CHANGE SHEET

FOR

NSTS 08060 - Space Shuttle
System Pyrotechnic Specification

CHANGE NO. 95

This change incorporates non-technical changes authorized by SSP DOC-519.

October 29, 2001

Robert H. Heselmeyer
Secretary, Program Requirements
Control Board

CHANGE INSTRUCTIONS

1. Remove the following listed Deviation/Waiver (D/W) pages and replace with the same numbered attached D/W pages:

D/W Page	PRCBD No.
(ix)	
(x) - (xi)	SSP DOC-519
(xii)	
(29)	
(30) - (32)	SSP DOC-519
(33) - (38) (Remove)	SSP DOC-519

2. Remove the following listed pages and replace with the same numbered attached pages:

Page	PRCBD No.
3-7	SSP DOC-519
3-8	
4-7	
4-8	SSP DOC-519

A-53	
A-54 - A-62	SSP DOC-519
A-63 - A-68 (Add)	SSP DOC-519

NOTE: A black bar in the margin indicates the information that was changed.

3. Remove the List of Effective Pages, dated June 22, 2001 and replace with List of Effective Pages, dated October 29, 2001.

4. Sign and date this page in the space provided below to show that the changes have been incorporated and file immediately behind the List of Effective Pages.

_____ _____

Signature of person incorporating changes Date

NSTS 08060 - Space Shuttle
Systems Pyrotechnic Specification

*Revision H (Reference PRCBD Nos. S052730A, dated 10/20/93; S060411, dated 12/7/93; S086783A, dated 12/16/93 and SSP DOC-158)

LIST OF EFFECTIVE PAGES

October 29, 2001

The current status of all pages in this document is as shown below:

Page No.	Change No.	PRCBD No.	Date
(i) - (v)	Rev. H	*	February 11, 1994
(vi) - (vii)	94	S040732P	May 31, 2001
(viii)	78	SSP DOC-243	March 1, 1995
(ix)	91	S061439R1	February 7, 2001
(x) - (xi)	95	SSP DOC-519	September 4, 2001
(xii)	89	S041062L	May 1, 2000
(1) - (4)	Rev. H	*	February 11, 1994
(5)	89	SSP DOC-452	February 9, 2000
(6) - (8)	Rev. H	*	February 11, 1994
(9) - (10)	94	S040732P	May 31, 2001
(11) - (12)	91	SSP DOC-478	October 16, 2000
(13) - (17)	Rev. H	*	February 11, 1994
(18)	78	SSP DOC-243	March 1, 1995
(19)	89	SSP DOC-452	February 9, 2000
(20) - (22)	91	S061439R1	February 7, 2001
(23) - (27)	78	SSP DOC-243	March 1, 1995
(28) - (29)	89	SSP DOC-452	February 9, 2000
(30) - (32)	95	SSP DOC-519	September 4, 2001
i - iv	Rev. H	*	February 11, 1994
v	81	S074058C	August 30, 1996
vi	91	S061439R1	February 7, 2001
vii	76	S041062D	February 3, 1994
viii - ix	Rev. H	*	February 11, 1994
x	80	S071024BT	December 30, 1994
xi - xii	Rev. H	*	February 11, 1994
1-1	81	S074058C	August 30, 1996
1-2	Rev. H	*	February 11, 1994
2-1 - 2-2	Rev. H	*	February 11, 1994
2-3 - 2-5	88	S061229	November 9, 1999

LIST OF EFFECTIVE PAGES

October 29, 2001

Page No.	Change No.	PRCBD No.	Date
2-6 - 2-8	Rev. H	*	February 11, 1994
2-9	80	S060690	February 4, 1996
2-10	94	S041062Q	June 5, 2001
2-11	Rev. H	*	February 11, 1994
2-12	79	S074051	October 18, 1995
2-13 - 2-14	Rev. H	*	February 11, 1994
3-1	94	S040732P	May 31, 2001
3-2	80	S060690	February 4, 1996
3-3	94	S040732P	May 31, 2001
3-4	78	SSP DOC-243	March 1, 1995
3-5	Rev. H	*	February 11, 1994
3-6	94	S041062Q	June 5, 2001
3-7	95	SSP DOC-519	September 4, 2001
3-8	94	S040732P	May 31, 2001
3-9 - 3-10	Rev. H	*	February 11, 1994
3-11	90	S071532	August 30, 2000
3-12	88	S061229	November 9, 1999
3-13 - 3-16	Rev. H	*	February 11, 1994
3-17	83	S041062H	June 27, 1997
3-18 - 3-20B	91	S061439R1	February 7, 2001
3-21	77	S041062E	July 27, 1994
3-22	76	S041062D	February 3, 1994
3-23	83	S041062H	June 27, 1997
3-24 - 3-27	76	S041062D	February 3, 1994
3-28	Rev. H	*	February 11, 1994
4-1 - 4-2	Rev. H	*	February 11, 1994
4-3	89	S041062L	May 1, 2000
4-4 - 4-5	Rev. H	*	February 11, 2000
4-6	89	SSP DOC-452	February 9, 2000
4-7	Rev. H	*	February 11, 1994
4-8	95	SSP DOC-519	September 4, 2001
4-9 - 4-13	Rev. H	*	February 11, 1994
4-14	76	S041062D	February 3, 1994
4-15 - 4-16	81	SSP DOC-319	September 12, 1996
5-1 - 5-8	Rev. H	*	February 11, 1994
6-1 - 6-4	Rev. H	*	February 11, 1994

LIST OF EFFECTIVE PAGES

October 29, 2001

Page No.	Change No.	PRCBD No.	Date
7-1	78	SSP DOC-243	March 1, 1995
7-2 - 7-4	Rev. H	*	February 11, 1994
8-1	Rev. H	*	February 11, 1994
8-2	89	SSP DOC-452	February 9, 2000
8-3	91	SSP DOC-478	October 16, 2000
8-4	88	S061229	November 9, 1999
9-1	78	S071024BT	December 30, 1994
9-2	81	SSP DOC-307	May 9, 1996
9-3 - 9-6	Rev. H	*	February 11, 1994
10-1 - 10-6	Rev. H	*	February 11, 1994
11-1	91	S061439R1	February 7, 2001
11-2	Rev. H	*	February 11, 1994
11-3	91	S061439R1	February 7, 2001
11-4 - 11-6	Rev. H	*	February 11, 1994
11-7 - 11-8	91	S061439R1	February 7, 2001
12-1 - 12-4	Rev. H	*	February 11, 1994
A-1 - A-23	Rev. H	*	February 11, 1994
A-24 - A-28B	94	S040732P	May 31, 2001
A-29 - A-30	91	SSP DOC-478	October 16, 2000
A-31 - A-43	89	SSP DOC-452	February 9, 2000
A-44 - A-53	91	S061439R1	February 7, 2001
A-54 - A-68	95	SSP DOC-519	September 4, 2001

INDEX OF DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT – Concluded

THIS PAGE INTENTIONALLY LEFT BLANK

nine nuts were successfully tested. These nine nuts represented 109.8% of the maximum outer web dimension allowed by drawing.

Functional testing 10% of a lot (or ten nuts minimum) provides confidence that variations in nut and booster performance are represented.

The frangible nuts use redundant booster cartridges to separate. Only one booster cartridge is used during the lot acceptance functional test.

EFFECTIVITY: STS-83 thru STS-93 and STS-95 thru STS-999

AUTHORITY: Space Shuttle PRCBD S041062H, dated 6/27/97.

117. REQUIREMENT: Paragraph 3.8.4.4.3.2 Frangible Nuts. The margin shall be demonstrated by firing a production cartridge in a nut having a separation cross section that is 115% of the maximum allowable cross section. If multiple cartridges/charges are used to achieve redundancy, this requirement must be satisfied using a single cartridge/charge. The margin requirement shall be demonstrated on each production lot. This test should be performed under the minimum allowable flight loading conditions that can exist at the time of functioning of the frangible nut. The SRB/ASRB frangible nut (MLP hold down) shall demonstrate margin with a separation cross section that is 110% of the maximum allowable structural cross section.

WAIVER: The above requirement shall be waived to permit use of lot AAN of SRB frangible nuts (MLP hold down). During lot acceptance test, one of two test nuts clamshelled enough to release the hold down stud, but failed to separate into two pieces. The two test nuts were manufactured to 110% of the maximum allowable cross section.

RATIONALE: The remaining nine nuts of the lot sample were remachined to 110% of the largest outer web represented in the lot. All nine nuts were successfully tested. These nine nuts represented 109.8% of the maximum outer web dimension allowed by drawing.

Functional testing 10% of a lot (or ten nuts minimum) provides confidence that variations in nut and booster performance are represented.

The frangible nuts use redundant booster cartridges to separate. Only one booster cartridge is used during the lot acceptance functional test.

EFFECTIVITY: STS-87 thru STS-93 and STS-95 thru STS-999

AUTHORITY: Space Shuttle PRCBD S041062H, dated 6/27/97.

118. REQUIREMENT: Retired per SSP DOC-519, dated 9/4/01. (Reference Space Shuttle PRCBD S092194, dated 6/9/98.) See Appendix A.

119. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S061439R1, dated 2/7/01). See Appendix A.

120. REQUIREMENT: Paragraph 4.4.1 Qualification by Tests. Testing is the basic method to be used in the qualification of flight hardware and GSE. Such tests shall be used to determine that the hardware is capable of performing its required operational functions in the known or anticipated environmental conditions. These tests will be designed to subject samples of the hardware to the worst case environments and stresses anticipated. Hardware requiring qualification by test, which is produced to identical design requirements by several manufacturing sources, shall be qualified, by test, for each source. Those environmental tests or stress conditions that would not be affected by a new vendor's process or procedure need not be repeated by test.

WAIVER: The above requirement is waved for the SRB parachute time delay reefing line cutters on lot ABJ due to three units failing to meet the time delay requirements:

S/N 2004255 and S/N 2004462 - Fired at ambient temperature had a delay time of 12.03 seconds and 8.91 seconds, respectively. Allowable range is 9.40 to 11.49 seconds.

S/N 2004425 - Fired at high temperature had a delay time of 11.49 seconds. Allowable range is 9.12 to 11.15 seconds.

RATIONALE: Worst case effect of time delay failures is parachute overload during development. The actual effect based on load analysis is no effect on parachute safety margins.

EFFECTIVITY: STS-100, STS-102, STS-104, STS-106 thru STS-999

AUTHORITY: Space Shuttle PRCBD S041062L, dated 5/1/00.

121. REQUIREMENT: Retired per SSP DOC-493, dated 2/22/01. (Reference Space Shuttle PRCBD S041062M, dated 8/28/00). See Appendix A.

122. REQUIREMENT: Retired per SSP DOC-493, dated 2/22/01. (Reference Space Shuttle PRCBD S041062N, dated 8/28/00). See Appendix A.

123. REQUIREMENT: Paragraph 3.7.1.3.1 Functional Testing of Samples from the Lot. The preferred method of performing age life testing is by functional testing of samples from the production lot. Lot samples shall be randomly chosen when practical. Each age life test shall consist of a minimum of five units each.

WAIVER: The above requirement is waived to permit use of the side hatch thruster pressure cartridges (P/N MC325-0041), lot WAB, with test results from only four test firings.

RATIONALE: All five firings were successfully completed. No data was recorded on firing No. 4 due to a pretrigger of the oscilloscope. Test results from the four firings were analyzed and demonstrated the functional reliability of lot WAB. Data from four of the five firings was well within the test pass/fail criteria. The unit for which no data was recorded fired with no anomalies observed during the post closed bomb inspection.

EFFECTIVITY: STS-98, STS-100, STS-102, STS-104, STS-105, STS-107 thru STS-999.

AUTHORITY: Space Shuttle PRCBD S061439R1, dated 2/7/01.

124. REQUIREMENT: Retired per SSP DOC-519, dated 9/4/01. (Reference Space Shuttle PRCBD S041062U, dated 3/7/01.) See Appendix A.

125. REQUIREMENT: Retired per SSP DOC-519, dated 9/4/01. (Reference Space Shuttle PRCBD S041062W, dated 3/28/01.) See Appendix A.

THIS PAGE INTENTIONALLY LEFT BLANK

military specification to satisfy the independent analysis requirement, detailed test procedures shall be prepared and submitted to the appropriate NASA center and prime contractor, if required, for approval.

Deviation/Waiver 75 is applicable to Paragraph 3.5.3.1.
Refer to the Deviations/Waivers Section in front of the document.

3.5.3.2 Explosive Material Contamination Control

Special precautions shall be taken to ensure that explosive material drawn for production use does not become contaminated. Specific instructions for in-process explosive material storage and handling shall be incorporated in supplier pyrotechnic device manufacturing procedures.

Bulk explosive materials shall be stored using techniques that satisfy the requirements of DOD 4145.26-M, DOD Contractors' Safety Manual for Ammunition and Explosives. In order to ensure that explosive materials do not become contaminated, special emphasis shall be placed on good housekeeping, container integrity, container placement, and elimination of all contaminant-promoting conditions. In addition, a rodent and insect-abatement program shall be instituted to prevent possible contamination from those sources. Detailed procedures shall be prepared by each pyrotechnic device supplier for contamination control of bulk explosive materials. These procedures shall be approved by the cognizant element contractor or NASA center, as appropriate.

3.5.4 Compatibility

All materials used in pyrotechnic devices shall be compatible with each other to the extent that no reaction occurs which might adversely affect the component or system performance or safety including transient compounds, liquid or gaseous, generated during curing or storage. Stability and compatibility testing shall be conducted on all explosive/component interfaces, including sealing materials, where test data or analyses for demonstrating stability of materials or compatibility of components is not available.

3.5.5 Fungus Resistant Materials

Non-nutrient materials shall be used wherever possible. Materials which are nutrients for fungi shall be treated with an approved fungicidal agent before use.

3.5.6 Proprietary Materials and Processes

The use of proprietary materials and processes shall be avoided whenever possible. Complete disclosure of all proprietary materials and processes shall be provided to the NASA prior to their approval for use in accordance with SE-R-0006.

3.5.7 Protective Treatment

Materials and parts that are subject to corrosion shall be treated with a protective coating that will not crack, chip, peel, or scale with age or when subjected to the environmental extremes applicable to the specific part or device.

3.5.8 Dissimilar Metals

Dissimilar metals which tend toward active electrolytic or galvanic corrosion when in direct contact with each other shall not be used in applications requiring direct contact. JSCM 8080, Standard M/P-4 is applicable.

3.5.9 Material Certification, Component Parts (ASTM E8-79)

3.5.9.1 Heat Treated Component

Tensile coupons and chemical analysis data shall be required from component parts which are heat treated after machining and exposed to operating pressures and/or primary structural loads. The supplier shall establish and the NASA Project Office shall approve the minimum acceptance criteria of the material properties listed below. Failure to meet these minimum acceptance criteria shall be cause for rejection of the component parts associated with those test coupons. Prior to acceptance, the supplier shall conduct tensile tests on each coupon part as defined by the procuring agency. A minimum of three standard tensile coupons from the component part lot materials shall be processed with the component parts. These coupons shall be tested in accordance with the detail drawing/specification requirements. The following data shall be obtained from the test coupons and recorded on the lot acceptance data sheets:

a. Ultimate tensile strength

b. 0.2% offset yield

c. Elongation

d. Reduction of area

Deviation/Waiver 112 is applicable to Paragraph 3.5.9.1
Refer to the Deviations/Waivers Section in front of the document.

3.5.9.2 Non-Heat Treated Component

For pyrotechnic device metallic component parts which are not heat treated after machining or exposed to operating pressures or primary structural loads, the standard

maintaining the components as a set. Components that are normally degraded during the functioning must be replaced. If other components are degraded the pressure test must be repeated. These tests may be performed at an appropriate level of assembly.

b. Devices that cannot be functionally verified as specified in Subparagraph a. because the unit would be destroyed must be accepted by pyrotechnic DLAT firings. The DLAT sample size shall not be less than two units.

c. Frangible devices shall be accepted by a minimum of five pyrotechnic DLAT firings. These firings shall demonstrate the required performance margin in a manner dependent on the design of the device. Frangible nuts shall demonstrate the required performance margin with a single production cartridge/charge if dual cartridges/charges are used. The cartridges used to activate these frangible devices shall have met the acceptance requirements of Paragraph 4.5.1.4.

4.5.1.6 Current/Time to Peak Performance Measurements

The data obtained in each destructive test for pressure generating cartridges shall have actual firing current and output pressure versus time recorded.

4.5.1.7 Detonation Performance Measurements

Detonating cartridges shall utilize a dent block acceptance criteria as delineated in MIL–STD–331. Detonating cord shall utilize pass/fail criteria delineated in the respective procurement specification such as detonation velocity, target material thickness, swell cap expansion, explosive jet penetration, etc.

4.5.1.8 Environmental Testing

Appropriate environmental acceptance testing shall be considered for each pyrotechnic device, either as a nondestructive test on the entire lot or as conditioning on the destructive test samples only.

4.5.1.9 Test Equipment, Setup, and Procedures

A detailed acceptance test procedure shall be prepared for each pyrotechnic device. This procedure shall cover the details of both nondestructive and destructive testing. All test fixtures and equipment required to perform acceptance testing shall be identified and detailed instructions for the use of all equipment shall be included. Redundant instrumentation shall be used to minimize loss of data. Specific accept/reject criteria shall be established for each required test. Examples of all forms required for documentation of test results shall be included. JSCM 8080, Standard G–18 is applicable.

4.5.2 Cartridge, Booster, Detonators, Initiators, Etc., Acceptance Tests

Prior to delivery and as a condition of acceptance the supplier shall conduct nondestructive tests on each device submitted for lot acceptance and destructive tests on a random sample of the lot (Paragraph 4.5.1.4) as specified in the table below. Acceptance tests need not be limited to those listed below:

ACCEPTANCE TESTS

Test	Applicable Paragraph
Examination of Product	4.5.2.2
Leakage Test	4.5.2.3
Radiography Test	4.5.2.4
Verification of NSI–1 Characteristics	4.5.2.5
Insulation Resistance (@50 VDC)	4.5.2.5.3
Destructive Performance Tests	4.5.2.6

Sequence of testing shall be specified by the element contractor except that the firing of the lot sample shall be conducted last and all units of this sample shall have undergone all other tests prior to firing.

4.5.2.1 General

Any cartridge found to be defective in any nondestructive test shall be rejected. The number of cartridges to be subjected to destructive testing from various lot sizes shall be in accordance with Paragraph 4.5.1.4. Failure of any device to meet performance requirements shall be cause for lot rejection. Pressure cartridges shall be fired in closed or vented test bombs as appropriate to their specific application per Paragraph 4.5.2.6.2. Detonating cartridges shall be fired with a test indentation fixture in accordance with MIL–STD–331. Neither the device nor the NSI shall fracture, except for the portion immediately surrounding the detonating charge.

Deviation/Waiver 101 is applicable to Paragraph 4.5.2.1.
Refer to the Deviations/Waivers Section in front of the document.

4.5.2.2 Verification of Explosive Weight

In addition to the requirements of Paragraph 4.5.1.3, a weight verification shall be performed on each device per Paragraph 3.11. Verify the device weight and include the manufacturing weight records in the data package.

every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Flight performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: flangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component; nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any tear-down and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as the used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord

production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 15 year life assigned: shielded mild detonating cord, Part Numbers MC325-0004-0728 through MC325-0004-0765, Part Numbers MC325-0004-2051 through MC325-0004-2090, and Part Numbers MC325-0004-2093 through MC325-0004-2100. Flexible confined detonating cord Part Numbers MC325-0004-0128 through MC325-0004-0139, inner window severance assembly Part Number MC325-0027-0006. The shelf life of the NSI/SII shall not be considered in determining the shelf life expiration date for the end item.

WAIVER: The above requirement is waived to permit the use of P/N SKD26100105-301, Lot HBR pressure cartridges for the four year age life extension test.

RATIONALE: The SKD26100105-301 cartridge is used in the Ku-band release nut, Ku-band guillotine, and RMS type-I guillotine which were subjected to single 85% charge weight cartridge firings during qualification. The maximum pressure expected from the qual lot 85% cartridges is approximately 4156 psi in a closed bomb. Lot HBR produces higher pressure than the 85% cartridges which were successful. Lot HBR will perform its design function. In addition, the cartridges are redundant in each application.

EFFECTIVITY: P/N SKD26100105-301 lot HBR (not to extend past June 1997)

AUTHORITY: Space Shuttle PRCBD S064489, dated 11/8/95.

118. REQUIREMENT: Paragraph 4.5.2.1 General. Any cartridge found to be defective in any nondestructive test shall be rejected. The number of cartridges to be subjected to destructive testing from various lot sizes shall be in accordance with Paragraph 4.5.1.4. Failure of any device to meet performance requirements shall be cause for lot rejection. Pressure cartridges shall be fired in closed or vented test bombs as appropriate to their specific application per Paragraph 4.5.2.6.2.

Detonating cartridges shall be fired with a test indentation fixture in accordance with MIL-STD-331. Neither the device nor the NSI shall fracture, except for the portion immediately surrounding the detonating charge.

WAIVER: The above requirement is waived to allow use of lot AAC SRB nose cap thruster pressure cartridges.

RATIONALE: During destructive Lot Acceptance Testing (LAT), one of ten pressure cartridges (S/N 2000249) produced a pressure versus time curve which was outside allowable boundaries.

An anomaly resolution team was assembled to investigate the failure. The team concluded that the most probable cause of the failure of S/N 2000249 was poor inhibiting of the outer diameter of the propellant grain. Analyses, assuming no inhibitor on the outer diameter of the propellant grain, show no significant effect on their performance of the nose cap ejection system.

EFFECTIVITY: BI-098 thru BI-101

AUTHORITY: Space Shuttle PRCBD S092194, dated 6/9/98.

119. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the component but the age life shall be tracked from the date of the DLAT of the loaded component. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.), the age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The

intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Flight performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: frangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component: nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any teardown and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be

the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 15 year life assigned: shielded mild detonating cord, Part Numbers MC325-0004-0728 through MC325-0004-0765, Part Numbers MC325-0004-2051 through MC325-0004-2090, and Part Numbers MC325-0004-2093 through MC325-0004-2100; flexible confined detonating cord Part Numbers MC325-0004-0128 through MC325-0004-0139; inner window severance assembly Part Number MC325-0027-0006. The shelf life of the NSI/SII shall not be considered in determining the shelf life expiration date for the end item.

WAIVER: The above requirement is waived to extend the use of the inner window severance assembly, P/N MC325-0027-0006, S/N 1716100004 for a total of 19 years.

RATIONALE: New GFE Expanding Tube Assembly (XTA) replacement hardware was erroneously scrapped by supplier and replacement hardware will be available in 14 months.

Explosive cord loaded with same type of explosive (HNS) showed no degradation in performance when tested at 29 years.

Accelerated testing of HNS shows no performance degradation in at least 50 years.

Detonation propagation test on March 6, 1998 of XTA from the same lot as presently installed in OV-104 showed no degradation in performance.

EFFECTIVITY: OV-104, Flight 21 thru Flight 24

AUTHORITY: Space Shuttle PRCBDs S061062A, dated 9/21/98 and S061062AR1, dated 11/17/98.

121. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended

function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the component but the age life shall be tracked from the date of the DLAT of the loaded component. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.), the age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Flight performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: frangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component: nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to

meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any tear-down and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 25-year life assigned.

WAIVER: The above requirement is waived to extend the use of 12 SRB drogue parachute reefing line cutters, P/N 10320-0001-802, S/N 2003501 thru 2003505, 2003493A thru 2003498A, and 2003500A without performing the shelf life extension test.

RATIONALE: The twelve SRB drogue parachute reefing line cutters are four years from destructive lot acceptance test and require age life test. There are no remaining reefing line cutters available from this lot to support a shelf life extension test.

Functional test of previous lots (Lots ABC tested in 1994, Lot ABD in 1996 and ABH in 1998) of seven second delay cutters were within specification limits and did not show any shifts due to age deterioration. All three lots were manufactured using the same lot of delay mixture.

The greatest variation in average delay time from the LAT firings above was added to the 3-sigma variation to give the worst case time delay that could be expected. This variation of 1.402 seconds or 20.6% of 6.813 seconds is less than the allowable ± 22%. Therefore, the use of these cutters will not result in any increase of drogue parachute loads.

EFFECTIVITY: BI-102 thru BI-104

AUTHORITY: Space Shuttle PRCBD S041062M, dated 8/28/00.

122. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the component but the age life shall be tracked from the date of the DLAT of the loaded component. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.), the age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age

life samples. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Flight performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: frangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component: nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any teardown and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 25-year life assigned.

WAIVER: The above requirement is waved to extend the use of the SRB main parachute 10-second and-17 second delay reefing line cutters, P/N 10320-0001-803, Lot ABG, and

10320-0001-805, Lot ABF without performing the shelf life extension test.

RATIONALE: These SRB main parachute delay reefing line cutters are four years from destructive lot acceptance test and require age life test. There are no remaining reefing line cutters available from these lots to support a shelf life extension test.

The pertinent requirements to evaluate for deterioration due to age are:

a. The cutters must sever the Kevlar reefing lines.

b. The delay times must be within ± 22% of nominal over all temperature ranges.

c. Delay time variance must be within 10% of average at a given temperature.

The performance parameters can be measured using flight data from the SRB Data Acquisition System (DAS) and post-flight inspection. The DAS is located in the forward skirt and records accelerations including those associated with main parachute deployment and disreef. The DAS also has a video camera with the main parachutes in the field of view on selected flights. Using the acceleration data with the parachute video, the actual deployment and disreef times can be accurately measured for each parachute. Data was collected on five flights. Lot ABF delays ranged from 16.47 to 17.93 seconds with a target of 17 seconds. Lot ABG delays ranged from 9.96 to 10.54 with a target of 10 seconds. All delay times were within 5.5% of average and nominal (target) values, meeting the 10% and 22% requirements defined in (b) and (c). All Lot ABF and ABG cutters flown have successfully actuated. All Kevlar reefing lines completely severed.

EFFECTIVITY: BI-102 thru BI-105

AUTHORITY: Space Shuttle PRCBD S041062N, dated 8/28/00.

124. REQUIREMENT: Paragraph 3.5.3.1 High explosive materials. The use of reclaimed high explosive materials is prohibited. The

number and types of high explosives in the Space Shuttle system shall be minimized. HNS, HMX, and RDX are the preferred high explosive materials. Lead azide use shall be limited to those applications where it has been demonstrated that a less sensitive material will not meet the reliability requirements. When used, lead azide shall be encapsulated or otherwise isolated from organic materials and copper and copper containment alloys. All high explosives may be furnished by the contractors and procured to the following specifications:

Material	Specification
HNS	WS 5003
HMX	MIL-H-45444
RDX	MIL-R-398
PETN	MIL-P-387
Lead Azide	MIL-L-3055 (Type I)
Lead Azide RD-1333	MIL-L-46225

A NASA letter of certification is required for contractors to procure RDX directly from the U.S. Army Armament Command. Requests for such letters shall be forwarded to the appropriate NASA Project Office for action. Each lot of high explosive shall be analyzed for conformance to the applicable military specification requirements. This analysis shall be performed upon receipt at the suppliers facility or prior to loading of the first pyrotechnic device lot using this explosive material lot. The analysis will be performed by a laboratory or test facility different than the facility which provided the original explosive manufacturer's test report. Test results shall be compared with the original test report for evidence of significant degradation which could impact the functional performance or shelf life of the affected pyrotechnic devices. Independent analysis of high explosive materials shall be repeated at five year intervals or prior to loading of the next lot of explosive devices until the life is expended or the high explosive lot is no longer used for loading of NASA pyrotechnic devices. In the event the pyrotechnic device supplier wishes to utilize test methods different from those described

in the applicable military specification to satisfy the independent analysis requirement, detailed test procedures shall be prepared and submitted to the appropriate NASA center and prime contractor, if required, for approval.

WAIVER: PETN Kit 8730 (CDF assembly Lots ABS, ABT, ABV, ABW, and ABY) is waived for minimum nitrogen content (17.38%) during the 5-year independent analysis.

RATIONALE: PETN Lot 8730 was successfully tested during the original analysis 5 years ago. During the recent 5-year independent analysis, this PETN lot failed to meet the minimum nitrogen content requirement (17.5% minimum, reference MIL-P-387C, Paragraph 3.2). Nitrogen test results were 17.38%, all other requirements were met. Subsequently, margin testing was conducted on 24 CDF assemblies representing Lots ABV, ABW and ABY. The tests successfully demonstrated detonation propagation at 8 times the maximum design gap (0.432 inch air gap between ends of CDF assemblies). These tests provide confidence that initiation sensitivity and CDF output have not been compromised. In addition, 1083 CDF assemblies have successfully functioned in flight. There have been approximately 300 CDF assemblies successfully ground tested. All have used PETN Lot 8730. There have been no detonation propagation failures. Critical functions are redundant.

EFFECTIVITY: BI-106

AUTHORITY: Space Shuttle PRCBD S041062U, dated 3/7/01.

125. REQUIREMENT: Paragraph 3.5.3.1 High explosive materials. The use of reclaimed high explosive materials is prohibited. The number and types of high explosives in the Space Shuttle system shall be minimized. HNS, HMX, and RDX are the preferred high explosive materials. Lead azide use shall be limited to those applications where it has been demonstrated that a less sensitive material will not meet the reliability requirements. When used, lead azide shall be encapsulated or otherwise isolated from organic materials and copper and copper containment alloys. All high explosives may be furnished by the contractors and procured to the following specifications:

Material	Specification
HNS	WS 5003
HMX	MIL-H-45444
RDX	MIL-R-398
PETN	MIL-P-387
Lead Azide	MIL-L-3055 (Type I)
Lead Azide RD-1333	MIL-L-46225

A NASA letter of certification is required for contractors to procure RDX directly from the U.S. Army Armament Command. Requests for such letters shall be forwarded to the appropriate NASA Project Office for action. Each lot of high explosive shall be analyzed for conformance to the applicable military specification requirements. This analysis shall be performed upon receipt at the suppliers facility or prior to loading of the first pyrotechnic device lot using this explosive material lot. The analysis will be performed by a laboratory or test facility different than the facility which provided the original explosive manufacturer's test report. Test results shall be compared with the original test report for evidence of significant degradation which could impact the functional performance or shelf life of the affected pyrotechnic devices. Independent analysis of high explosive materials shall be repeated at five year intervals or prior to loading of the next lot of explosive devices until the life is expended or the high explosive lot is no longer used for loading of NASA pyrotechnic devices. In the event the pyrotechnic device supplier wishes to utilize test methods different from those described in the applicable military specification to satisfy the independent analysis requirement, detailed test procedures shall be prepared and submitted to the appropriate NASA center and prime contractor, if required, for approval.

WAIVER: The minimum nitrogen content for superfine PETN Lot 8730 is waived for Lot ABS, ABT, ABV, ABW, ABY, and ACA CDF assemblies installed on STS-100 as follows:

Part Number, Serial Number and Lot Number Matrix

Part Number	Serial Number	Lot Number
10314-0001-101	2014226	ABW
10314-0001-101	2014227	ABW
10314-0001-102	2012750	ABT
10314-0001-102	2012751	ABT
10314-0001-103	2012765	ABT
10314-0001-103	2012766	ABT
10314-0001-104	2012776	ABT
10314-0001-104	2012777	ABT
10314-0001-105	2012922	ABV
10314-0001-105	2012923	ABV
10314-0001-106	2012937	ABV
10314-0001-106	2012938	ABV
10314-0001-107	2012951	ABV
10314-0001-107	2012952	ABV
10314-0001-108	2012971	ABV
10314-0001-108	2012972	ABV
10314-0001-109	2012988	ABV
10314-0001-109	2014306	ABW
10314-0001-110	2013003	ABV
10314-0001-110	2013004	ABV
10314-0001-111	2014328	ABW
10314-0001-111	2014329	ABW
10314-0001-112	2013038	ABV
10314-0001-112	2013039	ABV
10314-0001-113	2013060	ABV
10314-0001-113	2013061	ABV
10314-0001-114	2012447	ABS
10314-0001-114	2013076	ABV
10314-0001-115	2013099	ABV
10314-0001-115	2013100	ABV

10314-0001-116	2013116	ABV
10314-0001-116	2013117	ABV
10314-0001-117	2013137	ABV
10314-0001-117	2013138	ABV
10314-0001-118	2013154	ABV
10314-0001-118	2013155	ABV
10314-0001-119	2013172	ABV
10314-0001-119	2013173	ABV
10314-0001-120	2013185	ABV
10314-0001-120	2013186	ABV
10314-0001-121	2013204	ABV
10314-0001-121	2013205	ABV
10314-0001-122	2013226	ABV
10314-0001-122	2013227	ABV
10314-0001-128	2012799	ABT
10314-0001-128	3000288	ACA
10314-0001-129	2012817	ABT
10314-0001-129	3000301	ACA
10314-0001-140	2014193	ABY
10314-0001-140	2014194	ABY
10314-0001-141	2014213	ABY
10314-0001-141	2014214	ABY

RATIONALE: PETN Lot 8730 was successfully tested during the original analysis 5 years ago. During the recent 5-year independent analysis, this PETN lot failed to meet the minimum nitrogen content requirement (17.5% minimum, reference MIL-P-387C, Paragraph 3.2). Nitrogen test results were 17.38%, all other requirements were met. Subsequently, margin testing was conducted on 12 CDF assemblies representing Lot ACA, and on 24 CDF assemblies representing Lots ABV, ABW, and ABY. The tests successfully demonstrated detonation propagation at 8 times the maximum design gap (0.432 inch air gap between ends of CDF assemblies). These tests provide confidence that initiation sensitivity and CDF output have not been compromised. In

addition, 1,135 CDF assemblies have successfully functioned in flight. There have been approximately 300 CDF assemblies successfully ground tested. All have used PETN Lot 8730. There have been no detonation propagation failures. Critical functions are redundant.

Lots ABS and ABT CDF assemblies that were not represented in March, 2001 margin tests have been stored the same way as Lots ABV, ABW, and ABY. The storage environment is benign, the CDFs are sealed in desiccated bags. There have been no problem reports associated with CDF assembly storage. The PETN nitrogen content is a material issue rather than a CDF lot manufacturing issue. Therefore, margin testing of Lots ABV, ABW, and ABY is representative of Lots ABS and ABT.

EFFECTIVITY: BI-107

AUTHORITY: Space Shuttle PRCBD S041062W, dated 3/28/01.